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During the tenure of this contract I have been able to solve, in collaboration with P. Santini, a problem that has eluded investigators for many years: We have been able to charaterize solitons in multidimensions. It is well known that there exist several physically important equations in two dimensions (e.g. KdV, NLS) that support certain stable coherent structures called solitons. The solitons in the last 20 years have played an important role in the understanding of many physical and biological phenomena. Although there exist several equations in three dimensions, which share many features with the soliton equations in two dimensions (e.g. KP, DS), these equations could not so far support soliton solutions. We have recently found coherent structures for such equations; these structures have many novel properties not found in the 1+1 solitons and we have called them DROMIONS (see Ref. 1 and 2). The methods and results of Ref. 1 and 2 are quite generic. Indeed, the author and V. Zakharov have shown that in addition to Davey-Stewartson equation, many other physical significant nonlinear equations can support Dromions (Ref. 3).

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FINAL REPORT ON AFOSR-89-0148

During the tenure of this contract I have been able to solve, in collaboration with P. Santini, a problem that has eluded investigators for many years: We have been able to characterize solitons in multidimensions. It is well known that there exist several physically important equations in two dimensions (e.g. KdV, NLS) that support certain stable coherent structures called solitons. The solitons in the last 20 years have played an important role in the understanding of many physical and biological phenomena. Although there exist several equations in three dimensions, which share many features with the soliton equations in two dimensions (e.g. KP, DS), these equations could not so far support soliton solutions. We have recently found coherent structures for such equations; these structures have many novel properties not found in the 1+1 solitons and we have called them DROMIONS (see Ref. 1 and 2).

The methods and results of Ref. 1 and 2 are quite generic. Indeed, the author and V. Zakharov have shown that in addition to Davey-Stewartson equation, many other physical significant nonlinear equations can support Dromions (Ref. 3).

In addition to the above breakthrough I have made significant contributions in several other areas:

1. Boundary Value and Forced Problems. Using the method introduced by the author for the investigation of the nonlinear Schrödinger (NLS) on the half-line (see Ref. 4) we have made, in collaboration with M.J. Ablowitz, progress in solving certain forced problems (Ref. 5).

2. Soliton Cellular Automata. Particles and interaction of particles of a certain filter cellular automata have been analyzed exactly. This model exhibits behavior similar, but richer, to the well known soliton equations (Ref. [6-9]). The continuous limit of this model is under investigation.

3. Rigorous Aspects of Inverse Problems. In collaboration with L. Sung I have introduced a methodology for studying rigorously the inverse problems pertinent to the integrability of certain nonlinear equations (Ref. 10).

The author has lectured on the above work at several colloquia and Conferences: U. of Minneapolis, Columbia, U. of Pittsburg, U. of Pennsylvania, Courant Institute, Yale, Kiev, Turkey, Greece (see the enclosed announcement).

- New Manifestations of Solitons, Workshop on Solitons in Nonlinear Optics and Plasma Physics, November 7-11, 1988.

- Solitons and Cellular Automata, Columbia University, November 1988.
- The Integrability of the Davey-Stewartson Equation, University of Pittsburg, November 1988.
- Recent Developments in Soliton Theory, University of Pennsylvania State, November 1988.
- Multidimensional Solitons, University of Buffalo, February 1989.
- Coherent Structures in Cellular Automata, Technical University of Istanbul, Turkey, April 1989.
- Symmetries and Integrability, Research Institute for Basic Sciences, Kocaeli, Turkey, April 1989.
- New Manifestations of Coherent Structures, 5th International Conference on Solitons, Crete, Greece, July 1989.
- Coherent Structures in Multidimensions and in Cellular Automata, Courant Institute of Mathematical Sciences, September 1989.
- Integrability and Coherent Structures in Multidimensions, Yale University, October 1989.
- Coherent Structures and Integrability, IV International Workshop on Nonlinear and Turbulent Processes in Physics, Kiev, October 1989.

List of Publications

1. A.S. Fokas and P.M. Santini, Coherent Structures in Multidimensions, Phys. Rev. Lett., **63**, 1379 (1989).
2. A.S. Fokas and P.M. Santini, Coherent Structures and a Boundary Value Problem for the Davey-Stewartson I Equation, INS #121, Clarkson University, March 1989, to appear in Physica D.
3. A.S. Fokas and V.E. Zakharov, The Dressing Method Revisited, INS #137, Clarkson University, October 1989.
4. A.S. Fokas, An Initial-Boundary Value Problem for the Nonlinear Schrödinger Equations, Physica D, **35**, 167-185 (1989).
5. A.S. Fokas and M.J. Ablowitz, Forced Nonlinear Evolution Equations and the Inverse Scattering Transform, Stud. Appl. Math., **80**, 253-272 (1989).
6. A.S. Fokas, E. Papadopoulou, and Y. Saridakis, Particles in Soliton Cellular Automata, INS #107, Clarkson University, to appear in Complex Systems.
7. A.S. Fokas, E. Papadopoulou, Y. Saridakis and M.J. Ablowitz, Interaction of Simple Particles in Soliton Cellular Automata, Stud. Appl. Math., **81**, 153-180 (1989).
8. A.S. Fokas, E.P. Papadopoulou, and Y.G. Saridakis, Soliton Cellular Automata, INS #127, Clarkson University, to appear in Physica D.

9. A.S. Fokas, E.P. Papadopoulou, and Y.G. Saridakis, Coherent Structures in Cellular Automata, INS #126, Clarkson University, submitted to Physics Letters.

10. L.Y. Sung and A.S. Fokas, A Hyperbolic Inverse Problem of $N \times N$ Hyperbolic Systems on the Plane and Nonlinear Evolution Equations, INS #142, Clarkson University, submitted to Comm. in Pure Appl. Math.

English Translation of an Article on the Crete Conference

The 5th International Conference on Nonlinear Systems took place in the Orthodox Academy of Crete in the period of 2-16 July 1989. In this conference there were more than 100 participants from USA, Soviet Union, Europe, Asia, and Australia. Among the participants there were internationally known Mathematicians, Physists and Mathematical Physists like: Faddeev (President of the International Mathematical Association), Zakharov, and Marchenko from the Soviet Union and Kruskal and Fokas from the USA.

There were about 50 lectures as well as poster sessions and informal seminars. A lot of discussion took place among small groups of participants, as a result of which several new research projects were started.

The conference was about nonlinear phenomena in general, and about the integrability of certain nonlinear equations characterizing these phenomena, in particular. One of the most important properties of such equations in two dimensions is their ability to support certain stable coherent structures called SOLITONS. The solitons in the last 20 years, have played an important role in the understanding of many physical and biological phenomena. Also they have very useful applications like the transmition of information along optical fibers.

One of the most interesting results of the conference was the discovery that solitons also exist in equations of three dimensions (Fokas and other Italian scientists). This discovery may have applications in oceanography, geophysics, fluid mechanics, cosmology, quantum mechanics, nonlinear optics, plasma physics, etc. Also of interest was the discovery of the mathematical relatic ship between soliton equations and the so-called quantum groups (Fadeev and others).

This series of conferences began in 1980 by A. Verganelakis of Dimocritos, Greece, and by F. Calogero of the Physics Department of the University of Rome, Italy. The first two conferences (1980, 1983) took place in the Othodox Academy of Crete, the third in North Italy (1985) and the fourth in North France (1987). This conference was organized by A. Verganelakis and D. Levi of the University of Rome with the scientific advise of F. Calogero. The next conference will take place in 1991 in North Italy.